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Marketing Research Report No. 875

HANDLING PEACHES IN PALLET BOXES

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The author wishes to thank the packinghouse operators in Georgia and South Carolina who made their facilities available for study.

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HANDLING PEACHES IN PALLET BOXES

by

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SUMMARY

Results of studies undertaken in selected commercial peach packinghouses indicated that labor and equipment costs for handling peaches can be reduced by almost 13 percent by shifting from the present field box system to the use of pallet boxes. This reduction amounts to approximately \$0.03 per bushel of fruit handled, or about \$13,000 on an annual volume of 459,000 bushels of peaches.

The study was undertaken to determine the economic feasibility of pallet box handling based on labor and equipment costs. The annual labor and equipment costs for harvesting, transporting to the packinghouse, receiving, and dumping peaches by the pallet box method were compared with those for the field box method in a synthesized packinghouse operation for peaches.

During the study, standard labor and equipment data for the handling operations associated with pallet boxes and field boxes were developed. Operating conditions, typical of those prevailing in the industry, were specified for a synthesized peach packinghouse operation having the capacity to dump 750 bushels per hour. A pallet box and a field box handling system were developed for this operation. The standard labor and equipment data were used to determine operating schedules and labor and equipment requirements for each system. Annual labor and equipment costs for each system were estimated and compared.

In the synthesized operation, annual labor costs for the pallet box method were \$12,605, or 14 percent, less

than for the field box method. Eleven fewer workers were required for the pallet box than for the field box operation. Although the initial cost of equipment for the pallet box method was \$3,251, or about 8 percent, more than for the other method, the total annual equipment costs were \$358, or 3 percent, less. Total annual labor and equipment costs for the pallet box method were \$12,964, or 13 percent, less than for the field box method. Labor and equipment costs for the synthesized packinghouse operation are approximately \$0.03 per bushel less for the pallet box method. Since both labor and equipment costs were less for the pallet box method, packinghouse operators, regardless of the size of their operation, should consider converting to this type of handling. Their decision to convert should be based on the type of cost comparison made in this study. The data presented in this report will assist packinghouse operators in determining the economic feasibility of pallet box handling for their particular operations.

Findings of this study also emphasized a need for reducing the labor required to harvest peaches. Approximately 90 percent of the total labor required for the pallet box operation and 74 percent for the field box were for harvesting the fruit. The costs attributed to harvesting and the increasing difficulty of securing an adequate supply of labor at this time should justify a concentrated research effort aimed at reducing the labor required to harvest peaches.

INTRODUCTION

During recent years the pallet box has been used as a handling container for many agricultural products. It is an economical handling container for transporting large quantities of products or materials over long distances. The pallet box was not used for handling fresh fruits and vegetables for many years because growers thought that perishable commodities would be injured if handled in

this way. However, the need for continually improving methods of harvesting, transporting, storing, packing, and shipping these commodities has increased interest in its use.

The pallet box was first used successfully by the fresh fruit and vegetable industry for handling potatoes around 1944, demonstrating its feasibility for handling

fresh fruits and vegetables. Consequently, the use of pallet boxes was gradually accepted by the industry and is now being used successfully for handling apples, citrus fruits, pears, cherries, grapes, tomatoes, sweetpotatoes, walnuts, and many other horticultural crops.

Pallet boxes were first used for handling peaches for the fresh market in 1965, although they had been used for many years previously for handling clingstone peaches for processing. In 1965, several packers in Georgia and South Carolina replaced the traditional 1-bushel field box with a 20-bushel pallet box as a container for transporting peaches from the orchard to the packinghouse and dumping them onto the packing line.

At first, this conversion to pallet boxes created problems because satisfactory dumping equipment was not available. A flotation-type apple dumper that operated on the principle of submerging the pallet box into a tank of water and allowing the fruit to float to the surface was used. However, to make some varieties of peaches float, the specific gravity of the water had to be increased. Soda ash was added to the dump water for this purpose. The dumping technique and the use of soda ash in the dump water was not acceptable for peaches from the standpoint of effectiveness or maintenance of product quality. Not all the fruit was removed from the pallet box, and when soda ash was used, some discoloration of the fruit was detected after shipment.

Despite such problems, these packinghouse operators showed that peaches for the fresh market could be

handled in pallet boxes. They found that the percentage of fruit injured in handling was no greater, and often less, than they had experienced when using field boxes. The experiences of these packers stimulated interest in pallet box handling throughout the peach industry. Dumping equipment was subsequently improved, eliminating many of the problems associated with pallet box handling. This equipment, which does not require soda ash in the dump water, is described in detail in this report.

Pallet box handling of peaches for the fresh market was found feasible from the standpoint of effect on product quality; therefore, general acceptance by the industry will be based on economic considerations. Published information on the costs of handling peaches in pallet boxes is not available. This study was undertaken to establish guidelines that will enable packinghouse operators to determine the economic feasibility of converting to pallet box handling. The specific objective of this study was to compare the labor and equipment costs for pallet box handling with those for field box handling on the basis of operating conditions prevalent in typical commercial peach packinghouses.

The scope of this study encompasses only those operations related to harvesting the fruit, moving it to the packinghouse, and dumping it onto the packing line, because these are the only operations that are affected by the type of handling container used. Packing itself is not influenced by the type of container used to bring the fruit to the packinghouse.

RESEARCH PROCEDURES

A cost comparison between the pallet box and field box methods of handling peaches should be based on an evaluation of each method under identical operating conditions. This type of comparison could not be done, however, because it would have been impossible to locate packinghouses using each method under identical operating conditions. The approach used was to study each method under operating conditions existing in selected commercial packinghouses and using the results to evaluate each method on the basis of operating conditions specified for a synthesized peach packinghouse operation. This approach permits attributing any difference in costs between the two methods to the type of handling container since it was the only variable in the analysis.

Studies were made in eight commercial packinghouses in Georgia and South Carolina during the 1965 and 1966 peach seasons. The volume of fruit handled by these packinghouses ranged from approximately 400 to 1,000 bushels per hour. Labor and equipment requirements for

existing methods of handling peaches in pallet and field boxes were determined by stopwatch timestudy, motion picture timestudy techniques, predetermined time standards, and other industrial engineering techniques. Equipment specifications and costs were obtained from equipment manufacturers and wage rates for labor from the packinghouse operators. Standard labor and equipment data were developed for all handling operations associated with each method.

Operating conditions typical of those prevailing in the industry were assumed for the synthesized peach packinghouse operation. They were as follows: (1) Peaches for the operation were of varieties with maturity dates spaced to provide a uniform supply of fruit throughout the packing season; (2) orchards from which peaches were obtained were laid out with 100 trees to the acre, planted on 20-foot centers; (3) peaches on all trees matured at a rate that permitted obtaining one bushel of fruit from each tree each time it was picked; (4) the driving distance between all orchards and the centrally

located packinghouse was 5 miles; and (5) the operation had the capacity to dump peaches onto the packing line at a rate of 750 bushels per hour.

A pallet box handling system and a field box handling system were developed for harvesting, transporting to the packinghouse, receiving, and dumping peaches in the synthesized operation. For each system the flow of product was analyzed and the operations required and their sequence of occurrence were determined. The type of equipment and work methods specified for each system were those that were found to be the most effective in the packinghouse operations studied.

In a peach packinghouse operation, labor and equipment requirements should be determined concurrently with operating schedules if costs are to be minimized. The reason for this is that the various activities overlap in time and some of the workers and items of equipment

are utilized in more than one activity. In this study, it was assumed that peaches would be dumped at a constant rate of 750 bushels per hour after the packinghouse began operating. Labor and equipment requirements and operating schedules necessary to maintain a uniform flow of fruit from the orchard to the packinghouse throughout the day were determined for each method. Although this procedure permitted effective utilization of equipment, it resulted in tours of duty for some jobs that were greater than workers could be reasonably expected to maintain on a daily basis. Workers were assumed to be assigned to these jobs on a shift basis. Annual labor and equipment costs for harvesting, transporting to the packinghouse, receiving, and dumping peaches by each method were determined and compared.

PALLET BOX METHOD

The handling container for this method was a 47-inch square by 24-inch deep plywood pallet box (fig. 1). This container had a capacity of approximately 20 bushels of peaches, with a gross weight of approximately 1,130 pounds filled. In practice, this size of container is filled to about 18 bushels to prevent injuring the fruit when stacking. Recommended design specifications for this type of pallet box can be obtained from plywood manufacturers.



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Figure 1.—Pallet boxes used in this study being handled by a forklift truck.

The equipment needed to operate the synthesized operation at capacity when using pallet boxes follows: (1) 216 pallet boxes; (2) a gasoline-type forklift truck with a capacity of 2,500 pounds having a 106-inch lift and rubber-tired wheels for handling pallet boxes at the packinghouse; (3) a 2 1/2-ton truck with an 8- by 24-foot flatbed trailer that will hold 36 pallet boxes for transporting empty boxes to the orchard and filled boxes to the packinghouse; (4) a forklift truck, similar to the one at the packinghouse, but equipped with pneumatic tires for loading and unloading the truck and orchard wagons at the assembly area; (5) two 35-horsepower farm tractors, each equipped with an 8- by 12-foot flatbed orchard wagon that will hold six pallet boxes, for transporting empty and filled boxes between the assembly area and orchard; (6) a 35-horsepower farm tractor equipped with a forklift attachment for loading and unloading the orchard wagons in the orchard; (7) 93 1/2-bushel canvas picking bags; and (8) a pallet box dumper with a capacity of 42 pallet boxes per hour.

A crew of 100 workers¹ is needed to operate the synthesized operation at capacity when using pallet boxes. The crew is as follows: Two forklift truck operators (one at the packinghouse and one at the assembly area); one truck driver; two tractor drivers for the orchard wagons; one tractor-forklift operator; 93 pickers; and one pallet box dumper operator. The duties assigned to the workers and the work methods employed are described in the following sections.

¹The total number of workers required is based on the assumption that workers assigned to all jobs are on duty during the entire elapsed time for the job. In actual practice, workers may be assigned to some jobs on a shift basis.

Description of Operations

The flow of product and sequence of operations for the pallet box method are shown by the flow chart in figure 2. A daily activity schedule was developed (fig. 3) which coordinates all activities to attain maximum utilization of equipment and labor and to provide for a continuous flow of fruit from the orchard to the packinghouse throughout the day. The schedule shows the relative time periods during which all activities occur and their beginning and ending times.

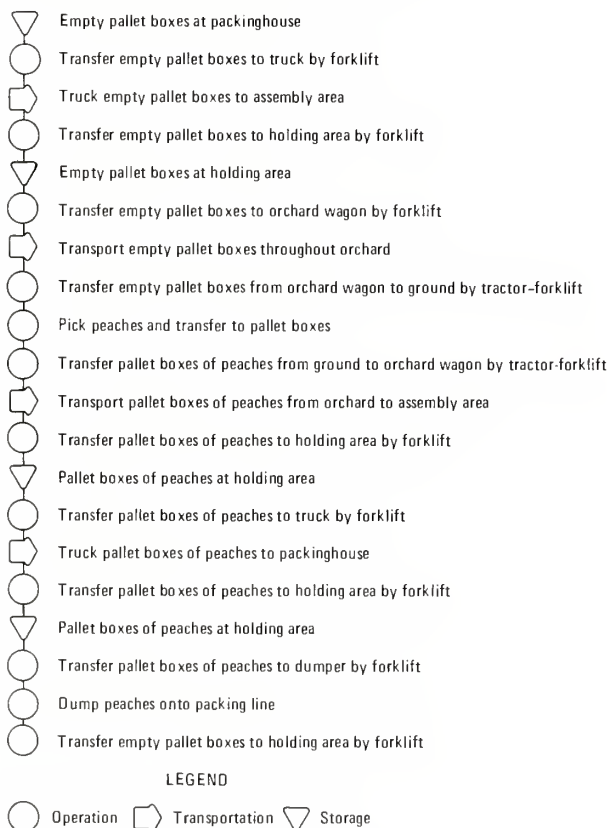


Figure 2.—Flow chart for pallet box method.

To simplify discussion, the operations were classified as follows: Transportation, orchard, and packinghouse. This treatment facilitates visualizing the overall operation of the system and understanding the relationships among the various activities.

Transportation Operations

The transportation operations include hauling empty boxes from the packinghouse to the assembly area and hauling filled boxes from the assembly area to the packinghouse. The 2 1/2-ton truck and trailer (fig. 4) has a capacity for 36² pallet boxes, empty or filled, at a

time. It makes 15 round trips per day between the packinghouse and assembly area. On the first five trips, empty boxes are hauled to the assembly area and the truck returns to the packinghouse empty. On the next five trips, the truck hauls empty boxes to the assembly area and returns to the packinghouse with filled boxes. On the last five trips, the truck travels to the assembly area empty and returns to the packinghouse with filled boxes.

Orchard Operations

The orchard operations include transferring empty boxes from the truck to the holding area, loading empty boxes onto the orchard wagons, distributing empty boxes in the orchard, picking and placing fruit in boxes, loading filled boxes onto the orchard wagons and transporting them to the assembly area, transferring filled boxes to the holding area for peaches, and loading the truck with filled boxes for transport to the packinghouse.

The forklift truck (fig. 5) is used for loading and unloading trucks and orchard wagons at the assembly area. Forklift truck time is allocated to these various activities as required. When the truck arrives at the assembly area (fig. 6) with a load of empties, it is positioned adjacent to both the holding area for empty boxes and the holding area for peaches. The forklift unloads the truck by transporting three boxes at a time to the holding area and stacking them. Empties are transferred, two at a time, from the holding area to the orchard wagons for distribution. The forklift unloads the orchard wagons by transporting one pallet box of peaches at a time to the holding area. The forklift loads the truck with fruit by obtaining two pallet boxes at a time from the holding area and transporting them to the truck.

The two orchard wagons and the tractor-forklift operate as a team in distributing empty pallet boxes and picking up pallet boxes of fruit in the orchard. When one of the orchard wagons has been loaded with six empty pallet boxes, it moves from the assembly area into the orchard. The forklift begins loading the other wagon with empties at the assembly area.

The tractor-drawn orchard wagon and the tractor-forklift move through the orchard together. The wagon stops at predetermined intervals³ and the tractor-forklift removes one empty pallet box at a time from the wagon and places it on the ground (fig. 7). By the time the first wagon is unloaded, the second one, loaded with empties, arrives in the orchard. The first wagon returns to the assembly area for another load of empties, and the tractor-forklift unloads the second wagon in a similar

²The stacking pattern consists of 2 rows of 6 boxes stacked 3 high.

³Empty pallet boxes are spaced throughout the orchard to minimize the distance that pickers must walk to transfer peaches to them.

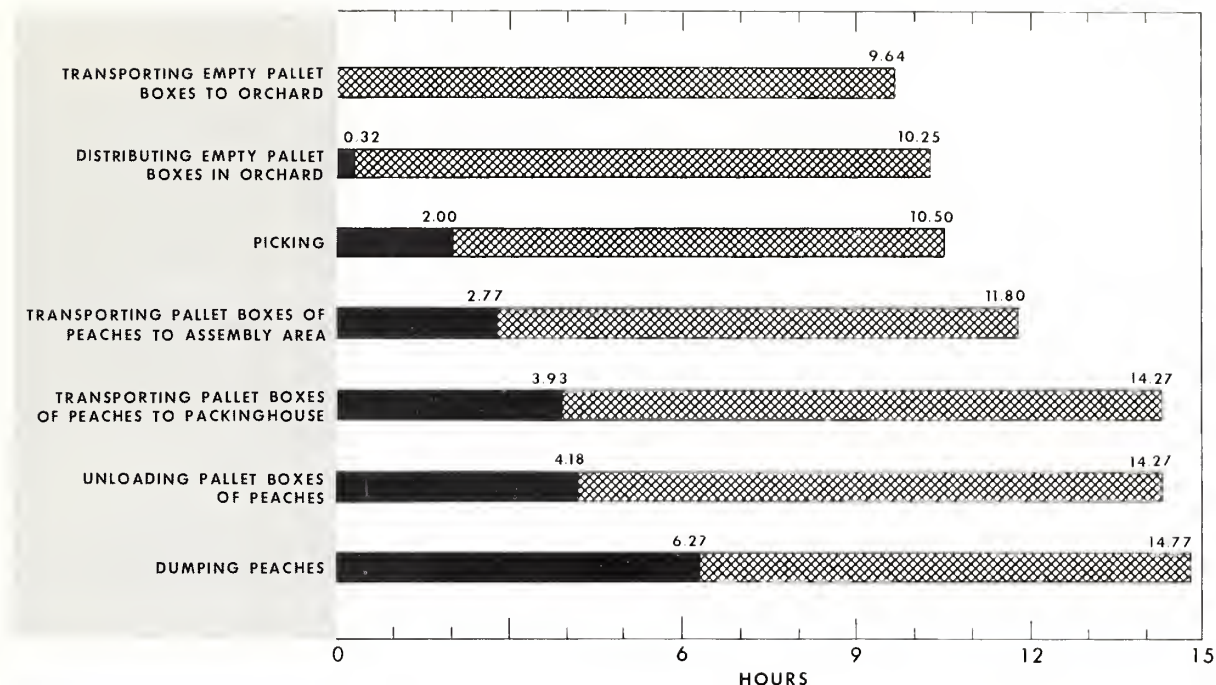


Figure 3.—Daily activity schedule for pallet box method.



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Figure 4.—Truck and trailer loaded with 36 pallet boxes.

manner. When the pallet boxes are filled, the tractor-forklift places them back on the orchard wagons to be returned to the assembly area. The tractor-forklift and orchard wagons are utilized for distributing empties and picking up fruit as required.

Picking begins when about three truckloads of empty boxes have been distributed in the orchard. Each worker in the 93-man picking crew is provided with a canvas



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Figure 5.—Forklift truck unloading empty pallet boxes from truck at assembly area.

picking bag (fig. 8) that holds approximately one-half bushel of peaches. The pickers remove fruit from the trees and place it in the picking bags. When a bag is filled, the picker walks to the nearest pallet box and dumps the peaches into it (fig. 9). The picking crew moves through the orchard leaving pallet boxes of peaches behind them. The peaches are picked up and hauled to the assembly area and then to the packinghouse.

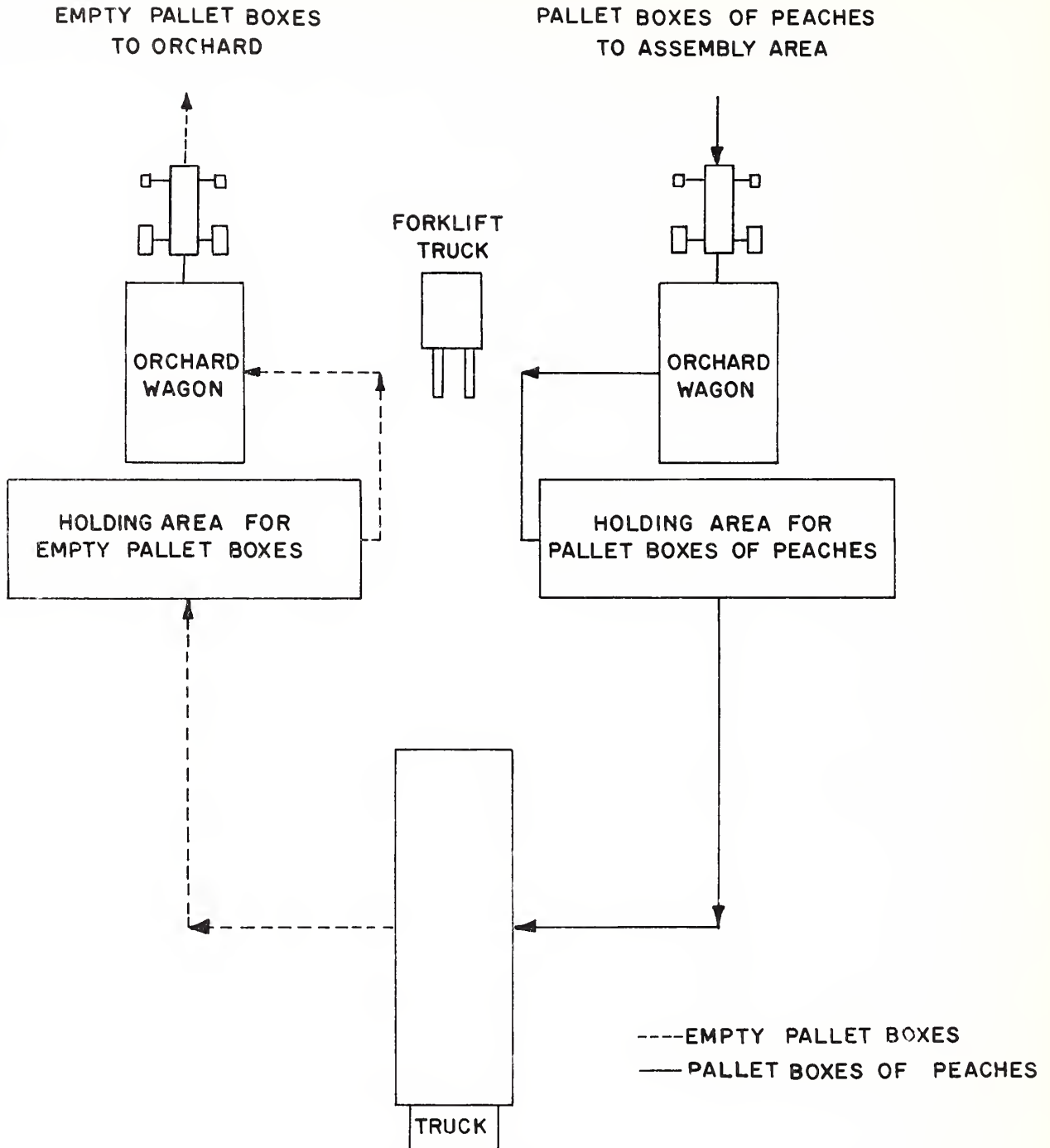


Figure 6.—Schematic layout of assembly area for pallet box method.



Figure 7.—The tractor-forklift transferring an empty pallet box from an orchard wagon to the ground.

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Figure 8.—Worker picking peaches and placing them in a $\frac{1}{2}$ -bushel canvas picking bag.



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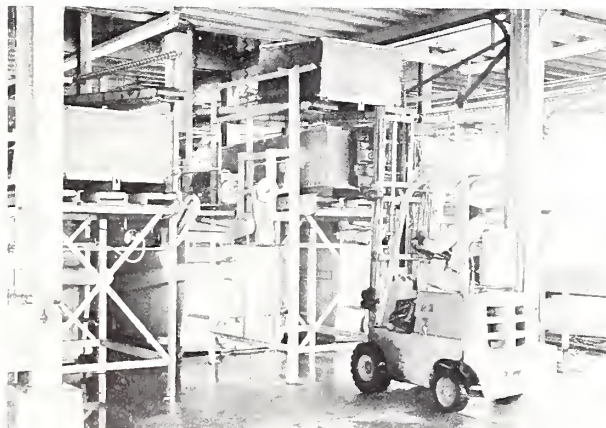


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Figure 9.—Pickers transferring peaches from picking bags to pallet box.

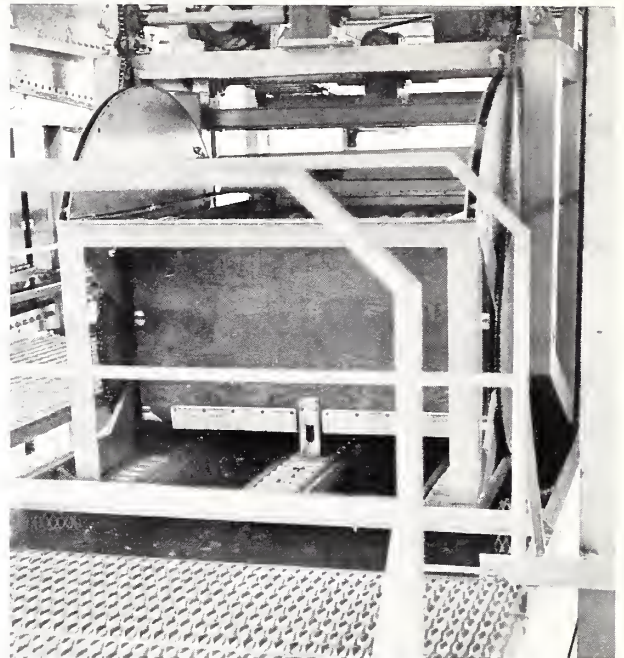
Packinghouse Operations

Understanding the operation of the pallet box dumper is essential to visualizing the packinghouse operations. The primary components of the dumper are a two-level roller conveyor, a dumping mechanism, and a dump tank. Pallet boxes of peaches are loaded onto the bottom conveyor of the dumper (fig. 10) which is powered and provides space for two boxes. One box at a



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Figure 10.—Pallet box of peaches being loaded onto dumper by forklift truck.

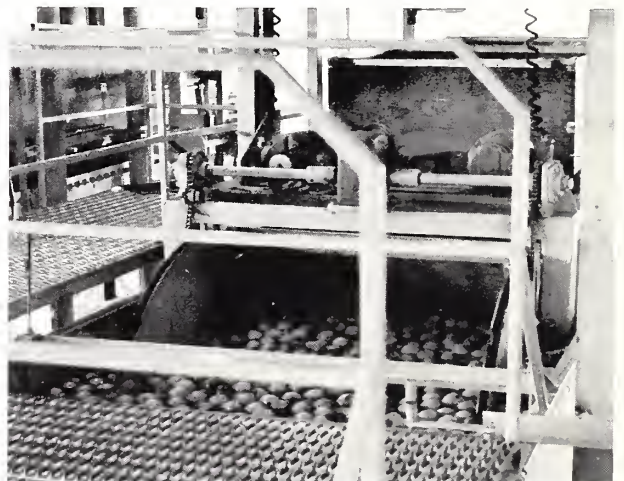


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Figure 11.—Pallet box of peaches being moved into carriage of dumping mechanism.

time is moved into the carriage-type dumping mechanism (fig. 11). The carriage can be moved up and down vertically and rotated approximately 270 degrees on its own axis.

When the box of fruit is in position, the carriage moves down submerging the box into the tank. The carriage is then rotated and the peaches are poured from the box into the water (fig. 12). Water in the tank is circulated to move the peaches to the discharge end of the tank. The fruit is moved out of the tank and onto



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Figure 12.—Carriage-type dumping mechanism being rotated to dump peaches from pallet box into water in dump tank.

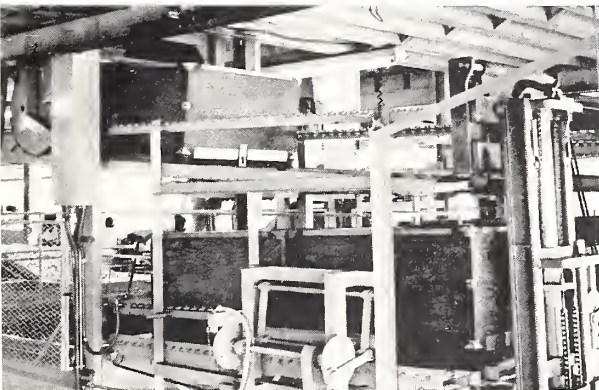
the packing line by the inclined section of the roller-grader that extends into the tank (fig. 13). The carriage is moved up out of the tank to a position alongside the top level gravity roller conveyor for empty pallet boxes (fig. 14). The carriage is tilted and the empty pallet box moves by gravity to the end of the conveyor where it is removed by forklift. A worker at the control panel (fig. 15) operates the dumper.

The packinghouse operations include loading the truck with empty pallet boxes, transporting filled boxes from the truck to the holding area, placing filled boxes on the dumper, transporting empty boxes from the dumper to the holding area, and operating the dumper. The forklift truck at the packinghouse is used for loading and unloading the truck and pallet box dumper. The method used by the forklift truck operator is dependent upon the number of activities that have to be performed simultaneously. The various methods can be



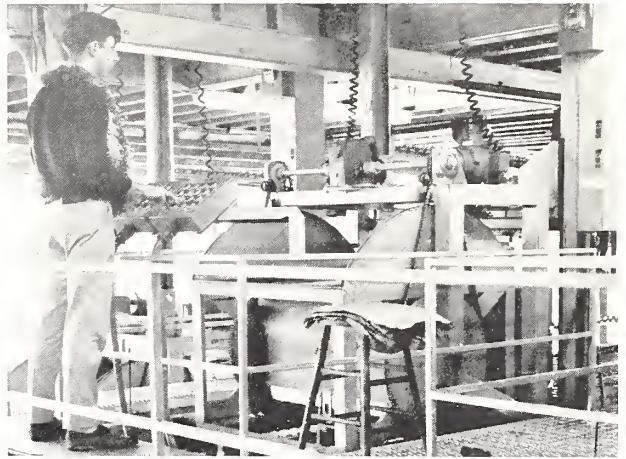
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Figure 13.—Peaches being transferred from dump tank to packing line by inclined section of roller-grader.



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Figure 14.—Empty pallet box moving from carriage onto conveyor for empty pallet boxes.



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Figure 15.—A worker operating control panel of pallet box dumper.

better understood by referring to the schematic layout of the receiving and dumping area (fig. 16).

Until the packing line begins operating, the forklift operator only has to load the truck with empty boxes for movement to the orchard and unload it when it returns to the packinghouse with peaches. The forklift operator loads the truck by transferring three boxes at a time from the holding area for empties to the truck. Filled boxes are unloaded from the truck, two at a time, and stacked in the holding area for peaches. During this period the forklift is idle when the truck is not at the packinghouse.

Dumping operations begin after about three truckloads of peaches have been unloaded at the packinghouse. One worker is needed to operate the dumper. During this period, the forklift operator loads and unloads the dumper as required when the truck is away from the packinghouse. When the truck is at the packinghouse, the forklift operator, in addition to serving the dumper, must unload the peaches from the truck and reload the truck with empties. The forklift operator must follow a definite work pattern to prevent disrupting the continuity of the overall system.

When the truck, loaded with fruit, arrives at the packinghouse, it is backed into the position shown on the layout drawing (fig. 16). Spaces occupied by the 12 stacks of three pallet boxes are numbered on the truck for identification. When the truck is in position, the forklift proceeds immediately to the number one stack. The two top boxes of the stack are removed from the truck and transported to the holding area for peaches and stacked. The forklift then returns to the truck and removes the remaining box of stack number one and transports it to the dumper. The filled box is placed on the dumper and an empty box is removed from the overhead conveyor, transported to the holding area for

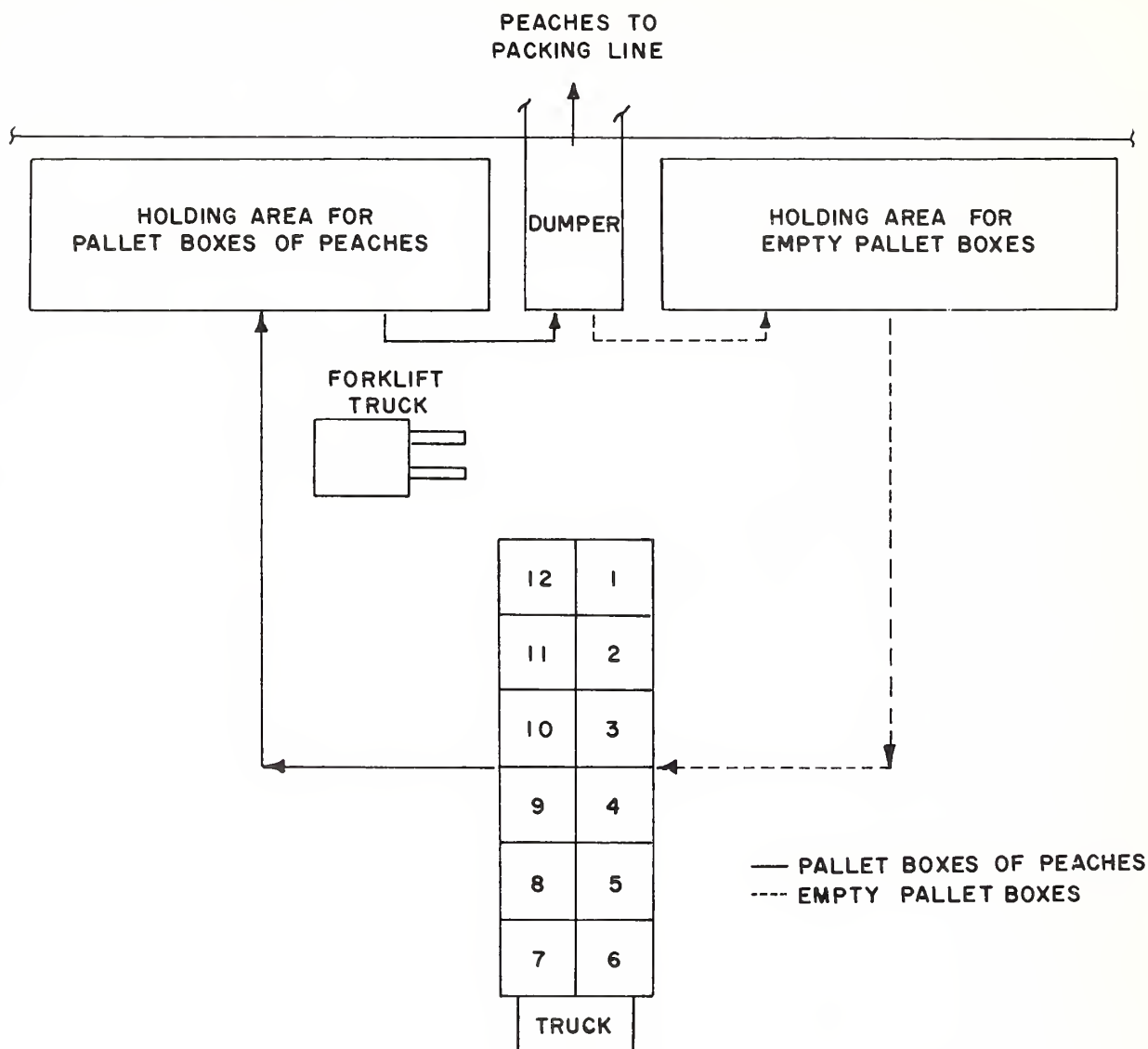


Figure 16.—Schematic layout of receiving and dumping area for pallet box method.

empty pallet boxes, and stacked. Then, a stack of three empties is obtained from the holding area and transported to the truck. This stack is placed on the truck in the space that was occupied by the number one stack of filled boxes. This procedure is repeated at each position (1-12) until all the peaches have been unloaded and the truck is reloaded with empties for return to the orchard.

The forklift truck follows essentially the same procedure when it is no longer necessary to return the empties to the orchard for reuse. The difference is that

after an empty box is removed from the dumper and stacked in the holding area, the forklift proceeds directly to the truck to unload the next stack of filled boxes.

Labor Requirements

The total labor required for the 100-man crew to harvest, transport to the packinghouse, receive, and dump 6,375 bushels of peaches per day by the pallet box method is almost 876 man-hours (table 1). Thus,

TABLE 1.—*Pallet box method of handling peaches: Labor requirements for harvesting, transporting to the packinghouse, receiving, and dumping 6,375 bushels of peaches per day*

Type of worker and duty	Workers required	Tour of duty ¹			Labor required		
		From	To	Elapsed time	Productive	Unproductive ²	Total
	<i>Number</i>	<i>Hours</i>	<i>Hours</i>	<i>Hours</i>	<i>Man-hrs.</i>	<i>Man-hrs.</i>	<i>Man-hrs.</i>
Forklift truck operator at packinghouse, loads and unloads truck and dumper.	1	0	14.77	14.77	8.98	5.79	14.77
Truck driver, hauls empty and filled boxes between packinghouse and assembly area. . . .	1	0	14.27	14.27	7.17	7.10	14.27
Forklift truck operator at assembly areas, loads and unloads truck and orchard wagons	1	.32	13.73	13.41	10.60	2.81	13.41
Tractor drivers for orchard wagons and tractor-forklift, transport empty pallet boxes from assembly area to orchard and distribute; pick up peaches in orchard and transport to assembly area.	3	.32	11.80	11.48	24.40	10.04	34.44
Pickers, pick fruit and place in pallet boxes	93	2.00	10.50	8.50	790.50	0	790.50
Pallet box dumper operator, controls operation of dumper	1	6.27	14.77	8.50	8.50	0	8.50
Total	100	—	—	—	850.15	25.74	875.89

¹ Zero hours represent the time that the first activity for the day begins.

² Unproductive labor is the time that crew members are idle because of unavoidable delays in work.

approximately 0.14 man-hours of labor is expended for every bushel of fruit handled. The crew members are unproductive (unavoidably delayed) for a total of almost 26 man-hours per day; therefore, approximately 97 percent of the total labor is utilized productively. Since pickers work as individuals, they are not delayed. Also, the operator of the pallet box dumper has no delay time since he always has fruit to dump. The elapsed time required for the completion of all operations with the specified equipment, crew size, and operating schedule is 14.77 hours.

Costs

Annual costs for labor and equipment for handling peaches in pallet boxes (based on operating 72 days per

year and an annual volume of 459,000 bushels of fruit) in the synthesized peach packinghouse operation were estimated as follows:

	Costs	
	Total	Per bushel
Labor	\$78,830.10	\$0.1717
Equipment	11,071.63	.0241
Total	89,901.73	.1958

Labor costs were based on labor requirements given in table 1 at an average wage rate of \$1.25 per hour. Equipment costs were based on appendix table 4. Approximately 88 percent of the total annual costs is for labor and the remaining 12 percent for equipment.

FIELD BOX METHOD

The handling container for this method is the standard field box (fig. 17). The plywood and cypress box is 18 inches long, 12 inches wide, and 13 inches deep. It holds approximately one bushel of peaches and has a gross weight of about 55 pounds filled.

The major items of equipment needed to operate the synthesized operation at capacity when using field boxes

are as follows: (1) 3,888 field boxes; (2) seven clamp-type 2-wheel handtrucks for handling field boxes at the packinghouse; (3) two dockboards for moving handtrucks between loading dock and truck bed; (4) three 2 1/2-ton trucks with 7- by 18-foot flatbeds for transporting empty boxes to the orchard and boxes of fruit to the packinghouse; (5) three 35-horsepower farm



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Figure 17.—A one-bushel field box filled with peaches.

tractors, each equipped with a 6- by 12-foot flatbed orchard wagon, for transporting empty and filled boxes between the assembly area and orchard; (6) 89 1/2-bushel canvas picking bags; and (7) a water dump tank equipped with an automatic field box dumper having the capacity to dump 834 field boxes per hour.

This synthesized operation needs a crew of 111 workers to operate at capacity.⁴ The crew is made up of the following workers: Six clamp-type 2-wheel hand-truck operators; three truck drivers; three tractor drivers for the orchard wagons and nine box handlers (three box handlers are assigned to each wagon); 89 pickers; and one loader for the automatic box dumper. The duties assigned to the workers and the work methods used are outlined in the section that follows.

Description of Operations

The flow chart and daily activity schedule for the field box method are shown in figures 18 and 19. The flow of product and overall operating procedures for the field box method are essentially the same as for the pallet box method, but the equipment and work methods are different. Transportation operations, orchard operations, and packinghouse operations for the field box method are described in the following sections.

Transportation Operations

The transportation operations include hauling empty field boxes from the packinghouse to the assembly area and boxes of fruit from the assembly area to the



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- Operation ▽ Storage
 ◻ Transportation

Figure 18.—Flow chart for field box method.

packinghouse. The trucks haul 432 empty boxes or 270 boxes of peaches per trip.⁵ The three trucks make 32 round trips per day between the packinghouse and assembly area. The trucks haul empty boxes to the assembly area and return to the packinghouse empty on the first six trips. They haul empties to the assembly area and return to the packinghouse with fruit on the next 11 trips. The trucks travel to the assembly area empty and return to the packinghouse with fruit on the last 15 trips.

Orchard Operations

The orchard operations include transferring empty boxes from the trucks to the orchard wagons, distributing empty boxes in the orchard, picking and placing fruit in boxes, transporting boxes of fruit to the assembly

⁵Peaches are handled in stacks of four field boxes. The load is limited to three orchard wagonloads which is 270 boxes, although the truck provides space for 72 stacks or 288 boxes of fruit. A truckload of empty boxes consists of 72 stacks of six boxes (boxes are nested so that a stack of six boxes occupies the space generally occupied by a stack of four—one box is placed on end in a second box and a third is inverted over them).

⁴See footnote 1, p. 3.

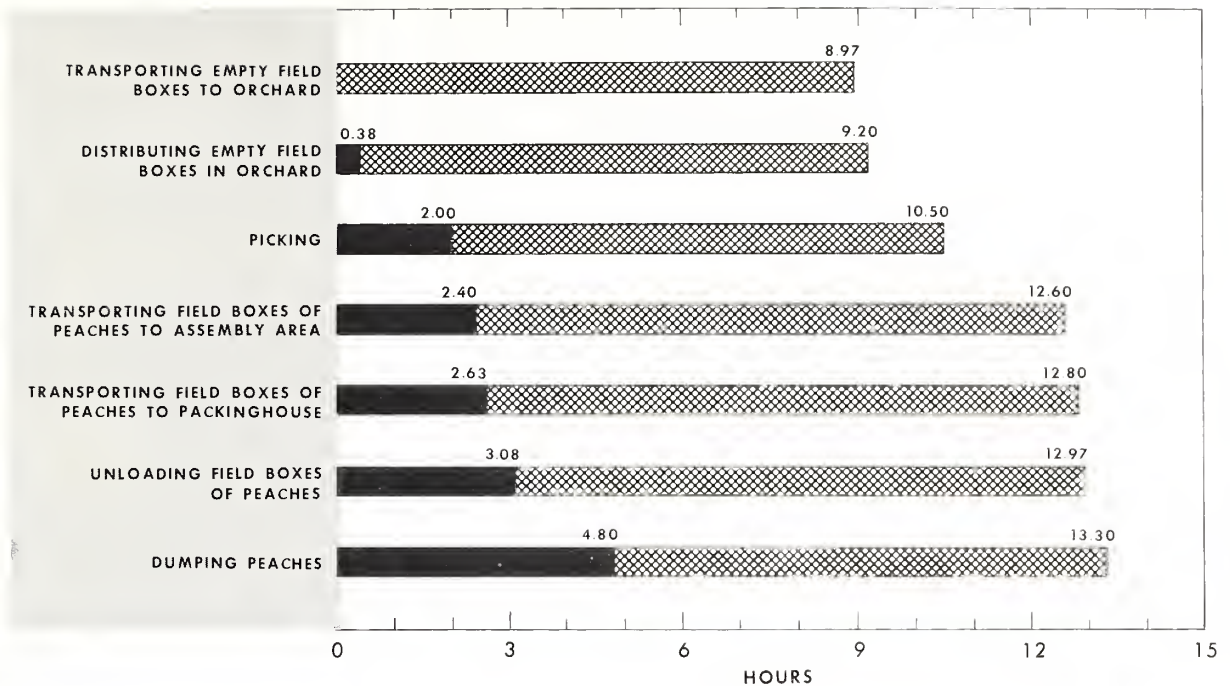


Figure 19.—Daily activity schedule for field box method.

area, and transferring boxes of fruit from the wagons to the trucks for transport to the packinghouse.

At the assembly area, empty boxes are transferred from the trucks to the orchard wagons and boxes of peaches are transferred from the wagons to the trucks by essentially the same method. When a truck loaded with empty boxes arrives at the assembly area, an orchard wagon is backed up to it as shown in figure 20. A four-man crew (the driver of the truck being unloaded and the three box handlers assigned to the wagon being loaded) transfer 144 empty boxes from the truck to the wagon. The workers handle the empty boxes in stacks of three. Two of them carry the boxes to the rear of the truck and place them on the truck bed, and the other two pick them up and stack them on the wagon.

When a truck is unloaded, it returns to the packinghouse for another load of empties or it is loaded with fruit to take to the packinghouse. The four-man crew uses essentially the same method in loading the truck with 270 boxes of fruit except they handle only one box at a time. A truckload of empty boxes or a truckload of fruit is equivalent to three orchard wagon loads.

The three orchard wagons are utilized for distributing empty boxes in the orchard and for picking them up and returning them to the assembly area after they are filled with fruit. Both of these operations are performed by essentially the same method. The orchard wagon is driven slowly between the rows of trees (fig. 21). One of



BN-32295

Figure 20.—Workers transferring peaches from orchard wagon to truck at assembly area.

the box handlers rides on the wagon and the other two walk along beside it.

When distributing empties, the box handler on the wagon slides the empty boxes to the edge of the wagon and the other two workers transfer them to the ground. Boxes are spaced throughout the orchard to minimize the distance pickers must walk. As soon as the wagon is unloaded, it returns to the assembly area for another load of empty boxes or it may be loaded with filled boxes of peaches.



BN-32294

Figure 21.—Worker transferring field boxes of peaches from ground to orchard wagon.

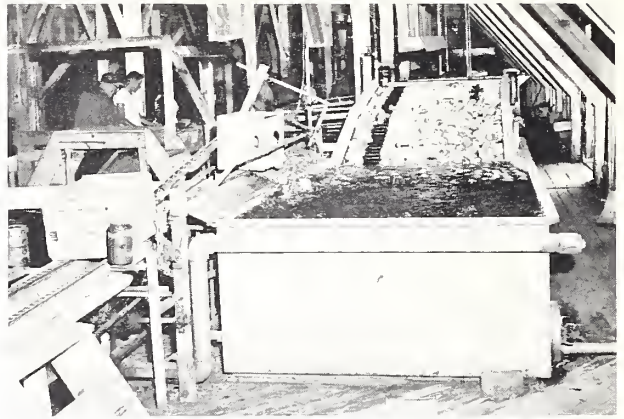
When picking up peaches, the wagon and crew move through the rows of trees and two of the box handlers transfer one field box at a time from the ground to the wagon. The other box handler stacks the boxes of fruit on the wagon. When the wagon is loaded, it moves to the assembly area and the peaches are transferred to a truck for movement to the packinghouse. The wagon crews allocate their time to distributing empty field boxes and picking up fruit as required.

Picking begins after about three truckloads of empty boxes have been distributed in the orchard. The pickers remove fruit from the trees and place it in 1/2-bushel picking bags. As bags are filled, workers walk to the nearest field box and dump the peaches into it. The picking crew moves through the orchard leaving boxes of peaches behind them. The boxes of fruit are picked up and hauled to the assembly area by the orchard wagons.

Packinghouse Operations

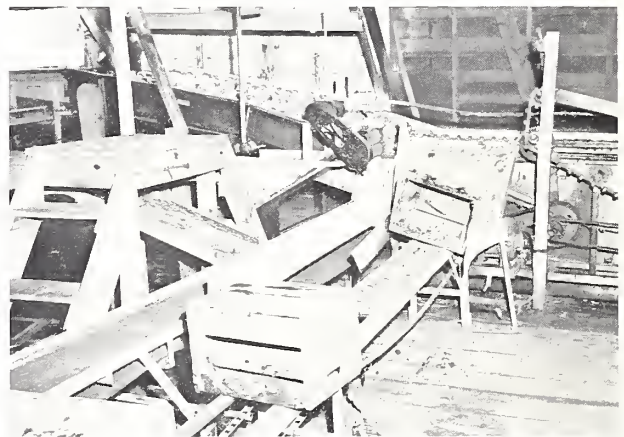
The dumping equipment for the field box method consists of an automatic field box dumper and a dump tank (fig. 22). Boxes of fruit are moved to the box dumper by a powered chain conveyor. The box dumper gradually turns the boxes on their sides as they are conveyed along the edge of the dump tank and the peaches roll gently from the boxes into the tank. Water is circulated so that the peaches are moved toward the roller-grader that extends into the tank. The peaches align themselves between the rollers and are moved out of the tank onto the packing line. At the end of the box dumper, empty boxes are diverted down a slide onto a powered chain conveyor (fig. 23), where they are removed and hauled to a holding area.

The packinghouse operations include loading trucks with empty field boxes, unloading trucks hauling peaches, transporting boxes of fruit from the holding



BN-32297

Figure 22.—Dump tank with an automatic field box dumper.

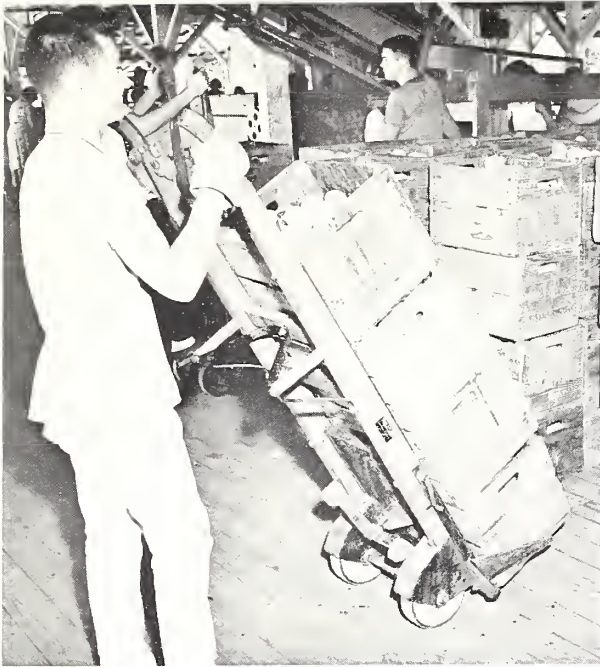


BN-32283

Figure 23.—Empty boxes are diverted from box dumper down slide to powered chain conveyor.

area to the dumper, transferring boxes of fruit to the dumper, and stacking the boxes after they are emptied and transporting them to the holding area. Clamp-type 2-wheel handtrucks (fig. 24) are used for handling empty boxes and boxes of fruit at the packinghouse. Work methods and operating procedures for this system can be better understood by referring to the schematic layout drawing of the receiving and dumping area (fig. 25).

Before the packing line begins operating, three handtruck operators are required for loading trucks with empty boxes and unloading trucks hauling peaches from the orchard. Loading and unloading operations are performed with the trucks positioned as shown in figure 25. A bridgeplate between the truck bed and dock facilitates movement of handtrucks between the two areas. To load a truck with empty boxes, operators of the clamp-type 2-wheel handtrucks obtain stacks of six boxes at a time from the holding area for empty boxes



BN-28560

Figure 24.—Worker transporting stack of four field boxes of peaches with a clamp-type 2-wheel handtruck.

and transport them to the truck. The handtruck operators unload trucks by transporting stacks of four boxes of peaches at a time from the truck to the appropriate holding area. Until the packing line begins operating, the handtruck operators are idle during periods when trucks are away from the packinghouse.

After three truckloads of peaches have been received, the packing line begins operating and a crew of seven workers, including the three handtruck operators already on duty, is needed at the packinghouse. The additional crew members and their assigned duties are as follows: One handtruck operator moves fruit from the holding area to a position alongside the conveyor to the box dumper (the three handtruck operators that load and unload trucks assist this worker when a truck is not at the packinghouse); one loader transfers the boxes of fruit to the conveyor; and two handtruck operators stack boxes after they are emptied and move them to the holding area.

The handtruck operators transport stacks of four boxes of peaches from the holding area to a position alongside the conveyor that carries boxes to the dumper. The loader transfers boxes of fruit, one at a time, from the stacks to the conveyor (fig. 26). The box dumper

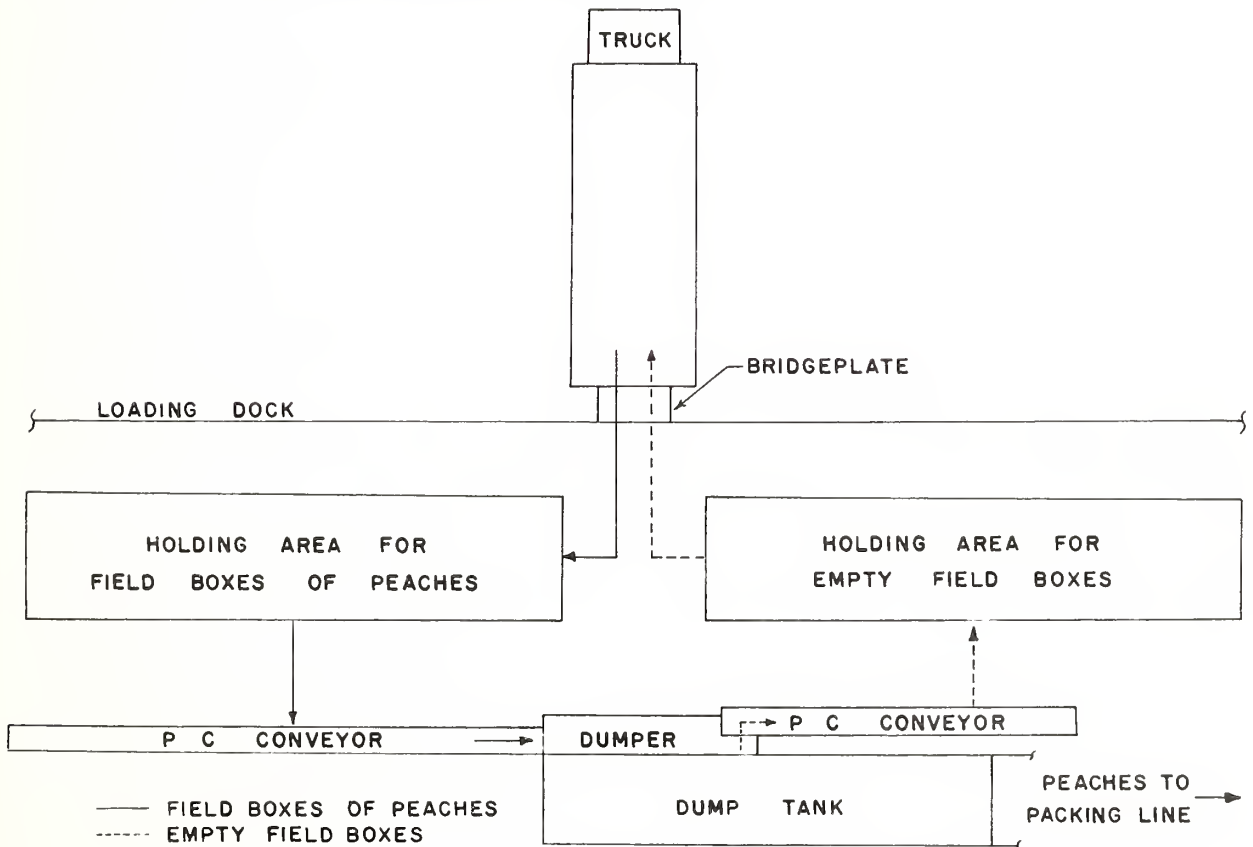
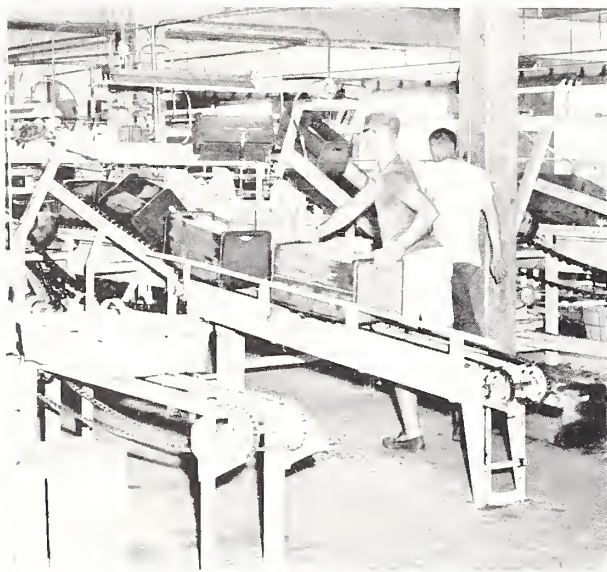


Figure 25.—Schematic layout of receiving and dumping area for field box method of handling peaches.



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"pours" the peaches into the dump tank and they continue moving over the packing line. Empty boxes accumulate on the powered chain conveyor that runs perpendicular to the end of the dump tank. Two handtruck operators assemble the empty boxes in stacks of six and transport them to the appropriate holding area. Empty boxes are returned to the orchard for reuse as needed.

Labor Requirements

The total labor required for the 111-man crew to harvest, transport to the packinghouse, receive, and dump 6,375 bushels of peaches per day by the field box method is almost 1,016 man-hours (table 2). The labor requirement per bushel of fruit handled is approximately 0.16 man-hour. The crew members are unproductive (unavoidably delayed) a total of about 25 man-hours per day; therefore, approximately 97 percent of the total labor is utilized productively. The elapsed time required for the completion of all operations with the specified equipment, crew size, and operating schedule is 13.30 hours.

TABLE 2.—*Field box method of handling peaches: Labor requirements for harvesting, transporting, receiving, and dumping 6,375 bushels of peaches per day*

Type of worker and duty	Workers required	Tour of duty ¹			Labor required		
		From	To	Elapsed time	Productive	Unproductive ²	Total
	Number	Hours	Hours	Hours	Man-hrs.	Man-hrs.	Man-hrs.
Handtruck operators at packinghouse:							
Load and unload trucks ³	3	0	13.30	13.30	32.07	7.83	39.90
Transport peaches from holding area to dumper.	1	4.80	13.30	8.50	8.50	0	8.50
Transport empty boxes from dumper to holding area	2	4.80	13.30	8.50	15.32	1.68	17.00
Truck drivers, transport empty boxes and peaches between packinghouse and assembly area and assist in loading and unloading operations	3	0	12.97	12.97	32.61	6.30	38.91
Tractor drivers and box handlers for orchard wagons, unload and load orchard wagons, distribute empty boxes in orchard, and transport boxes of fruit to assembly area. . . .	12	.38	12.60	12.22	137.81	8.83	146.64
Pickers, pick and place fruit in boxes	89	2.00	10.50	8.50	756.50	0	756.50
Loader, transfers boxes of fruit to dumper.	1	4.80	13.30	8.50	7.68	.82	8.50
Total	111	—	—	—	990.49	25.46	1,015.95

¹ Zero hours represent the time that the first activity for the day begins.

² Unproductive labor is the time that crew members are idle because of unavoidable delays in work.

³ When these workers are not loading and unloading trucks, they transport fruit from the holding area to the dumper.

Costs

The annual labor and equipment costs for handling peaches in field boxes in the synthesized peach packinghouse operation are estimated as follows:

	Costs	
	Total	Per bushel
Labor	\$91,435.50	\$0.1992
Equipment	11,430.11	.0249
Total	102,865.61	.2241

Labor costs were based on requirements given in table 2 at an average wage rate of \$1.25 per hour; equipment costs were based on appendix table 4. Approximately 89 percent of the total annual costs are for labor and the remaining 11 percent for equipment.

CONCLUSIONS AND RECOMMENDATIONS

Data on costs of labor and equipment derived in this study are compared in table 3. Initial cost of equipment is \$3,251, or about 8 percent, greater for the pallet box than for the field box method. However, the total annual costs for equipment for the pallet box method are about \$358, or 3 percent, less than for the field box method. The difference in the annual costs of equipment can be attributed primarily to the handling container. The number of pallet boxes required to handle the specified volume of fruit have a lower initial cost than the number of field boxes required to do the same job. In addition, pallet boxes have a longer expected life than field boxes, resulting in lower annual ownership costs.

Annual labor costs for the pallet box method are about \$12,605, or almost 14 percent, less than that for the field box method. Although the pallet box method required 11 fewer workers than the field box method, four more pickers were required. The reason for this is that the productivity of pickers is reduced when using pallet boxes because they must walk greater distances between the trees and handling containers than when using field boxes. Pallet boxes are centrally located within groups of 20 trees whereas field boxes are located within the immediate vicinity of the trees. The labor

required for picking the fruit and placing it in containers is about 4 percent greater for the pallet box.

The total annual labor and equipment costs for the pallet box method are \$12,964, or almost 13 percent, less than for the field box method. Even though this cost comparison was based on operating conditions specified for a synthesized operation, the results provide an economic basis for peach packinghouse operators to decide whether they wish to shift to pallet box handling. These studies indicate that packinghouse operators, regardless of size, should consider converting to the pallet box as a handling container.

The results of this study emphasize the urgent need for mechanizing the harvesting operation. Approximately 90 percent of the total labor required for pallet box handling and 74 percent for field box handling is for picking the fruit and placing it in the handling container. The use of pallet boxes reduced the total labor requirement, although the number of pickers required increased. The difficulty of obtaining picking labor and the potential savings that could be realized by the peach industry should justify a concerted research effort to mechanize harvesting.

TABLE 3.—Costs for handling 459,000 bushels of peaches in pallet boxes and field boxes in the synthesized peach packinghouse operation

Method	Initial cost of equipment	Annual equipment costs			Annual labor cost	Labor and equipment costs	
		Ownership	Operating	Total		Annual	Per bushel
Pallet box ¹ ..	Dollars 41,836	Dollars 7,392.19	Dollars 3,679.44	Dollars 11,071.63	Dollars 78,830.10	Dollars 89,901.73	Dollars 0.1958
Field box ² ..	38,585	7,662.53	3,767.58	11,430.11	91,435.50	102,865.61	.2241

¹ 100 workers required.

² 111 workers required.

APPENDIX

TABLE 4.—Ownership and operating costs of equipment for harvesting, transporting, receiving, and dumping 459,000 bushels of peaches per year, by the pallet box and field box methods

Specified equipment	Total initial cost ¹	Expected life	Ownership costs				Operating costs			Total annual cost
			Depreciation	Interest ²	Insurance and taxes ³	Total	Power ⁴	Maintenance ⁵	Total	
	Dollars	Years	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Pallet box method										
216 20-bushel-plywood pallet boxes	3,456.00	8	432.00	103.68	138.24	673.92	—	138.24	138.24	812.16
2 2,500-pound capacity forklift trucks with 106-inch lift (gasoline-powered)	10,600.00	8	1,325.00	318.00	424.00	2,067.00	316.80	424.00	740.80	2,807.80
1 2 1/2-ton truck with flatbed trailer	4,600.00	10	460.00	138.00	184.00	782.00	324.00	462.00	786.00	1,568.00
2 35-horsepower farm tractors	7,700.00	10	770.00	231.00	308.00	1,309.00	604.80	308.00	912.80	2,221.80
1 35-horsepower farm tractor with forklift attachment	4,200.00	10	420.00	126.00	168.00	714.00	432.00	168.00	600.00	1,314.00
93 1/2-bushel picking bags	280.00	2	140.00	8.40	11.20	159.60	—	11.20	11.20	170.80
1 pallet box dumper with capacity of 42 pallet boxes per hour	11,000.00	12	916.67	330.00	440.00	1,686.67	50.40	440.00	490.40	2,177.07
Total pallet box method	41,836.00	—	—	—	—	7,392.19	—	—	3,679.44	11,071.63
Total equipment cost per day for 72 days						153.77				
Field box method										
3,888 1-bushel field boxes	4,860.00	3	1,620.00	145.80	194.40	1,960.20	—	194.40	194.40	2,154.60
7 clamp-type 2-wheel hand-trucks	875.00	12	72.92	26.25	35.00	134.17	—	35.00	35.00	169.17
2 magnesium dock boards	230.00	15	15.33	6.90	9.20	31.43	—	9.20	9.20	40.63
3 2 1/2-ton flatbed trucks	13,800.00	10	1,380.00	414.00	552.00	2,346.00	691.60	921.60	1,613.20	3,959.20
3 35-horsepower farm tractors	11,550.00	10	1,155.00	346.50	462.00	1,963.50	1,123.20	462.00	1,585.20	3,548.70
89 1/2-bushel picking bags	270.00	2	135.00	8.10	10.80	153.90	—	10.80	10.80	164.70
1 dump tank with automatic box dumper with capacity of 834 boxes per hour	7,000.00	12	583.33	210.00	280.00	1,073.33	39.78	280.00	319.78	1,393.11
Total field box method	38,585.00	—	—	—	—	7,662.53	—	—	3,767.58	11,430.11
Total equipment cost per day for 72 days						158.75				

¹ 1967 f.o.b. prices plus installation cost if applicable.² 6 percent of average investment (computed at 50 percent of initial cost).³ 4 percent of initial investment.⁴ Includes cost of electricity at \$0.03 per kilowatt-hour and fuel at \$0.30 per gallon.⁵ 4 percent of initial investment for all equipment items except the 2 1/2-ton trucks; maintenance costs for trucks computed at rate of \$0.04 per mile.